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Rooftop gardening: Avenue for healthy living

Rooftops are underutilized and rarely-considered urban spaces with great potential for terrace gardening. Rapid urbanization, industrialization, land ceiling, construction of buildings, wide roads, offices, markets have resulted in non-availability of land for kitchen gardening activities in big cities and towns. Metropolitan cities have driven out agriculture from their boundaries. Owing to changing climatic conditions, a lot of pesticides and chemicals used in cultivation of fruits and vegetables affect the health of human beings.

SPACE available in the terrace can be effectively utilized for growing fruits, vegetables, spices and herbal plants. It might be roof, porch, terrace or balcony. Instead of garden around the house the plants can be transferred to the existing roof or floor of multi-story apartments, single-storey houses, office premises, storage warehouses. A well-planned terrace garden ensures round the year supply of fruits and vegetables. Involvement in the maintenance of the roof garden will help relieve stress and strains leading to healthy lifestyle. Rooftop gardening can be an attractive and energy-saving alternative as it keeps buildings cooler, saves energy, extends aesthetic value to the useable space on roof.

Points to be considered before planning a rooftop garden

- *Assessment of suitability of rooftop for garden:* Examine the structural integrity of the building and make sure the roof can hold the load. Soil and pots are heavy and will get heavier as the plants grow.
- *Drainage and waterproofing of roof:* Make suitable arrangement for drainage of excess water from irrigation and rainfall. The roof where you are planning to plant your greens should be waterproof, frost-resistant, and durable, especially the areas where you will be planting your greens and placing the pots. Waterproof the rooftop with the use of plastic sheets, polymer coating, etc. The waterproofing membrane to be installed for rooftop should be root and rot-resistant.

- *Sunlight exposure:* When it comes to cultivating any type of plant, sunlight is critical. Make sure you are well-versed with seasonal and daily sun exposure. The site should be open area with plenty of sunlight for 6 to 8 hours at least. The kind of plants, vegetables, flowers, and herbs one can grow on the roof gardens are determined by the amount of sunshine available.
- *Access to the roof:* Access to the roof is an important consideration. Typical access includes stairs and there should be enough space for transporting materials for construction and maintenance.
- *Availability of water for irrigation:* Plants must be watered regularly therefore consider an irrigation system or drip irrigation that will do the job automatically. At least, provision of water tank and tap should be there for watering plants.

Types of rooftop garden

Container gardening: Container gardening is a less expensive and highly flexible form of gardening that is especially effective for urban settings with little or no changes to the existing roof structure. Container gardening involves placing containers on a rooftop and filling them with soil and plants. It helps to avoid problematic soil by taking soil from area with healthy soil which can be further supplemented with compost produced from the garden's organic wastes as well as additional organic wastes produced within the building. Containers can be built from a variety of materials ranging from plastic drum, buckets, earthen pots, cement bags, storage container, wooden

Capsicum in pots

Drip irrigation in terrace garden

boxes that are readily available in household. Container gardening is particularly useful for people who lack the means or the will to make changes to the actual structure of the roof. Containers also have the advantage of providing depth and space for soil and roots, which is difficult to obtain with extensive green roof systems.

Green roof system: The second sort of roof garden, in which the rooftop is used as the planting medium, requires more investment but has its own set of benefits, such as better storm-water retention and building insulation. Specially designed layers separate the garden from the hard roof, provide drainage, supply nutrients, and even add contours. This type of rooftop garden is referred as a green roof system. There are two types of green roof systems extensive and intensive. An extensive green roof weighs lesser than an intensive green roof. It generally has shallower growing material and heartier plants that require little maintenance. Intensive green roofs are most like gardens on the ground–with deeper growing material, more intricate plantings, and more maintenance needs such as irrigation and pruning. Green roofs are constructed using a special base layer comprising root and water-proof membrane followed by a root barrier, water retention, drainage layer and lastly soil layer for growing plants. Usually, shallow rooted vegetables are grown in roof gardens and seedlings are removed after maturity periodically for roof garden maintenance.

Rooftop hydroponics: In the third rooftop garden possibility, plants are grown on a soilless media. Hydroponics is a means of growing plants with a substrate other than soil which may include peat, sand, rockwool, coconut coir, perlite or vermiculite. A nutrient solution is used to water the plants. Rooftop hydroponics is the lightest of the three choices, and it may allow for faster plant development and higher yield. There are two basic hydroponic systems: a non-recycled nutrient solution, where the nutrient solution is only used once; and a recycled nutrient system. There are also many variations within these two systems and various models and designs are available for use. There are six main types of hydroponic systems to consider for the garden–wick hydroponic system, deep water culture (DWC), nutrient film technique (NFT), ebb and flow, aeroponics, and drip systems.

• *Wick hydroponic system:* It is the simplest type of hydroponic system used to grow plants. It is easy to maintain and does not require aerators, pumps, or electricity. The plants are placed directly within an absorbent substance like perlite or vermiculite covered with nylon wicks into the nutrient solution.

• *Nutrient film technique (NFT):* In this system, the nutrient solution is pumped into channels that hold plants. The channels are slightly sloped, so the nutrient solution flows through the channel, over the plant's roots and back into the hydroponic reservoir. NFT hydroponic system works best for plants that have a small root system, like leafy vegetables.

- *Deep water culture (DWC) system:* Plants are placed in a net pot and are held by a floating platform above a container of nutrient and water. Plant roots are suspended and stretched into the nutrient-rich oxygenated solution. DWC is comparatively low cost, easy to build and water saving active recovery system. It just requires a net pot, a reservoir/container, a lid, and a pump.
- *Ebb and flow hydroponic systems:* It is also called flood and drain system where plants are placed in large grow beds filled with growing medium. The bed is flooded with nutrient solution until it reaches a certain point. Water pump after running for a predetermined amount of time, shuts off draining the grow bed completely. Nutrient solutions are flooded onto the plant root system and then drain periodically in cyclic manner.
- *Aeroponics:* Plant roots are suspended in the air and are misted with the nutrient solution continuously. The misting interval is fairly short, done by a pump controlled by a timer. Aeroponic system is expensive, and requires regular maintenance as nozzles sparing nutrient mist get choked.
- A drip system is an easy-to-use hydroponic system that can be quickly altered for different types of plants, which makes this a great system for any grower who plans to make regular changes. Drip system pumps the nutrient solution through the tube and drops onto plant roots via a network of drip lines. At the end of each tube is a drip emitter that controls the amount of nutrient solution provided to plants as per the need of individual plant.

Planning a terrace garden

Layout: The layout of rooftop garden is the first and most important step while setting up a terrace garden. One can either cover the entire surface with soil or use planters to grow plants. Earthen or cement pots or plastic pots can be used to set up a garden. Create an aesthetic

Table 1. Season wise vegetables for terrace garden

Vegetable name	Growing season - North India	Growing season - South India	Germination temp. (in °C)	Sowing method	Days to maturity
Brinjal	Feb-Mar, May-June, Oct	Jan-Feb, Oct	21-27	Nursery of 25-30 days & transplanting of seedling	100-110 days
Pumpkin	Jan-Mar Sept-Dec May-Jun	Jun-Jul Dec-Jan	20-35	Direct seeded	70-75 days
Cucumber	Feb-Mar, Jun Jul	Jun-Jul Sept-Oct Dec-Jan	16-32	Direct seeded	50-70 days
Beans	Feb-Mar	Jan-Mar	16-30	Direct seeded	45-50 days
Apple Gourd	Feb-Mar Jun-Jul	Feb-Mar Jun-Jul	20-30	Direct seeded	70-80 days
Bitter Gourd	Feb-Mar Jun-Jul	Nov-Dec Dec-Jan Jun-Jul	20-30	Direct seeded	55-60 days
Bottle Gourd	Feb-Mar Jun-Jul	Nov-Dec Dec-Jan Jun-Jul	20-30	Direct seeded	55-60 days
Broccoli	Aug-Sept	Aug-Sept	21-23	Nursery of 25-30 days & transplanting of seedling	90-100 days
Cabbage	Sept-Oct	Jun-Jul Oct-Nov	10-20	Nursery of 25-30 days & transplanting of seedling	90-100 days
Beetroot	Oct-Nov	Aug-Nov	10-30	Direct seeded	80-90 days
Capsicum	Nov-Jan May-Jun	Jan-Feb May-Jun Oct-Nov	15-25	Nursery of 25-30 days & transplanting of seedling	95-100 days
Carrot	Aug-Sept-Oct	Aug-Nov	10-30	Direct seeded	75-80 days
Lettuce	Sept-Oct	Oct-Dec	7-27	Direct/Transplant	45-55 days
Okra	Feb-Mar Jun-Jul	Jan-Feb May-Jun Oct-Dec	20-32	Direct seeded	50-60 days
Onion	May-Jun	Mar-Apr May-Jun Sept-Oct	10-32	Transplant	150-160 days
Peas	Sept-Oct-Nov	Sept-Oct-Nov	10-22	Direct seeded	55-60 days
Radish	Aug-Jan	Sept-Nov	10-30	Direct seeded	40-45 days
Spinach	Sept-Nov Feb	Sept-Oct-Nov	10-22	Direct seeded	60 days
Tomato	Jun-Aug Nov-Dec	Jan-Feb Jun-Jul Oct-Nov	20-30	Nursery of 25-30 days & transplanting of seedling	110-115 days
Turnip	Oct-Nov	Oct-Nov	15-35	Direct seeded	40-50 days
Cauliflower (Early)	Mid-June	Jun-Jul Aug-Sept	25-27	Nursery of 25-30 days & transplanting of seedling	120-125 days
Cauliflower (Late)	Aug-Sept-Oct	Jun-Jul	16-20	Nursery of 25-30 days & transplanting of seedling	120-125 days
Cauliflower (Mid-season)	Sept-Oct	Jun-Jul Aug-Sept	<16	Nursery of 25-30 days & transplanting of seedling	120-125 days

Fruiting in tomato plants

Use of discarded buckets, tubs and tanks for growing vegetables in terrace garden

and functional development plan based on the possibilities and constraints of the site, according to your tastes, your needs, and your budget.

Selection of plants: Depending upon the availability of the space, different types of vegetables and fruits can be grown on the terrace garden (Table 1). In addition to fruits and vegetables, think of putting herbal and medicinal plants in your garden. Diversification of plants in the garden is a guarantee for success in a healthy and varied diet. In fact, it will enable you to have access to a higher number of nutritional elements as each food has different characteristics.

Soil preparation: In general, the soil used should be fertile, containing the correct levels of moisture and minerals. Fresh soil from any farm with the right amount of organic manure and vermicompost is good for the purpose. Organic manure or aged manures are the best ways to prepare the soil for gardening as they supply almost every nutrient to the plant. For home gardening, soil mixes are available in nurseries. Potting soil is a mixture of peat moss, vermiculite, perlite and compost that is specially formulated to ensure good water retention and good drainage in pots and containers. Coco peat is also a very popular choice for home gardeners as it helps in water retention, aeration for roots and protects the plant from soil fungus. Priority is given to mixtures that are very lightweight and do not contain chemical fertilizers. Homemade compost or vermicompost is the ideal addition since it will allow to complete the food cycle at household.

Sowing: The seed of vegetables like lady finger, clusterbean, bitter gourd, bottle gourd and radish are directly sown in the growing medium. The seedling of vegetables like brinjal, tomatoes and chillies, etc. have to be raised in portrays and then transplanted in polybags. These seeds take 25 to 30 days to be eligible for transplantation.

Management: The use of organic fertilizers and organic way of pest control can be adopted. To avoid infestation of pests some amount of organic pesticides can be mixed in the soil. The plants can be sprayed with neem oil to control sucking pests which is a major problem in rooftop gardening. The neem oil is mixed in 10 litre of water with addition of 10 g of soap mixture and sprayed over affected vegetable plants. The spray made out of ginger, garlic and chilli paste diluted in water is also very effective in pest control.

Government initiatives in promoting rooftop gardening

State governments in some states under the Rashtriya Krishi Vikas scheme and Smart City development is offering 50% subsidy on seeds, fertilizers and farming equipment. House owners with a minimum of 50 to 300 square foot space in their balconies or backyard are eligible for availing 50% subsidy. The gardening and horticultural activities on the rooftops will help in improving the environmental conditions and restoring the climatic imbalance to an extent. Agriculture Skill Council of India (ASCI) conducts training programme on Rooftop Gardener, aims at building the following key competencies amongst the learner:

- Design and execute a rooftop garden as per the instructions received.
- Grow and maintain the condition of plants on a rooftop garden.
- Use and maintain the gardening tools, containers and other equipment.
- Monitor the plants and identify the potential damage due to insect, pests and diseases and learn how to control them.
- Practice health and safety at the work place: Well versed with health and safety measures in terms of personal as well as others safety and introduction to harmful practices of designing and execution.

The type of rooftop garden design depends partly on your interest in gardening and maintenance, and on the environmental benefits you wish to achieve. Rooftop plantings can interact with the heat produced by the building. Vegetation can work to cool buildings by insulating and shading as well as improving urban air quality. Once a rooftop has been developed for gardening, it remains that way, regardless of design, model and size. A rooftop garden is an investment in peace of mind for people living in urban areas, providing hours of relaxation and reward in the form of nutritional supplementation to family.

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